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Management of Root Caries

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Bachelor of Dental Surgery

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Certification of supervisor

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Dedication

To my heart family who stand with me at every step and never let me alone till this moment of my life and have the most role in my success, they gave me the power to stay strong and never fall down.

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List of Abbreviation

Abbreviation	Meaning
ACC-CPP	Casein Phosphopeptides-Amorphous Calcium Phosphate
APF	Acidulated Phosphate Fluoride
ART	Atraumatic Restorative Treatment
CT	Conventional Treatment
Dfs	Decayed Filled Surface
Er YAG	Erbium YAG Laser
GIC	Glass Inomer Cement
HA	Hydroxyapatite
ICDAS	International Caries Detection and Assessment System
NAF	Sodium Fluoride
PAA	Polyacrylic Acid
RC	Root Caries
RCIs	Root Caries Index
RCL	Root Caries Lesion
RMGIC	Resin Modified Glass Ionmer Cement
SDF	Silver Diamine Fluoride
SMD	Standard Mean Difference
SNF2	Stenous Fluoride

Introduction

As the world's population is ageing and people tend to retain more teeth compared to older generations, root caries is expected to be one of the main challenges in dentistry (Hariyani et al.,2018). Newly more consideration has been paid on avoidance of root caries since there is an increase in life expectancy and increase in number of natural teeth among the elderly people (Gluzman, 2013). Nearly more than half of elderly people have affected with root caries (Cheng, 2013). Root caries lesion often found as a soft carious lesion in root dentin of a tooth, usually there is a cavity beneath the cemento enamel junction. Root caries is a multifactorial disease that can be prevented (Gluzman, 2013).

Root surface that is exposed to oral environment become a risk predictor for the initiation and progression of root caries. There are several factors also related with the occurrence of root caries in elderly people , including socioeconomic educational level ,location of the municipality, income, and the concomitant presence of coronal caries lesions (Hayes et al., 2014; López et al., 2017).

In root caries, not only does bacterial acidification occur, but also organic material (mainly collagen) degradation by proteases because composition of surfaces of root including a great amount of organic material (Takahashi, 2008).

The approach to control root caries lesion include mechanical removal of biofilm and the utilization of toothpastes that contain fluoride , predominantly those that contain high concentration of fluoride , and other fluoride topical agent (Kidd, 2015; Heasman et al, 2017).

The management of root caries become important public health problem in elderly people because people are maintaining more teeth and with the expected increase in root caries over time, so there is high need for prevention and treatment (Gerritsen, 2010). Several reviews critically evaluated the treatment methods for root caries lesion (RCL) from a specific aspect, such non - invasive approaches , therapeutic agents used in the treatment, as well as from a periodontal perspective (Schwendicke and goste meyer, 2017).

Restoration of root caries lesions presents a number of operative challenges including difficulties with moisture control and bonding to dentine. So, another approaches may be needed for the restoration of root caries (Vanobbergen, 2014).The restoration used for root caries are glass ionomer cement(GIC), resin-modified glass ionomer cement (RMGIC), amalgam , polyacid modified resins (compomers) or composite resins (Stacey et al., 2017).

Aim of this r e v i e w

The aim of review is to focus on management of root caries .

REVIEW OF LITERATURE

1. Root Caries

Root caries was defined as soft, progressive lesion that is found anywhere on the root surface that has lost its connective tissue attachment and is exposed to the environment .By definition, root caries refers to caries that occur on the root surface of the tooth. Root caries lesion is not a recent oral disease (Garg, 2013). Because people living for longer period and retaining more of teeth into old age ,there is an increase in prevalence of root caries)Lamster,2016)

The disease is considered the most common cause for tooth loss in the elderly after periodontitis, occurring when root surface is exposed to the oral environment for instance, due to gingival recession and mechanical injury (Dinakaran, 2017). The root caries formation is a dynamic process of demineralisation and remineralisation and caries could develop when the equilibrium of factors disrupted and favour demineralisation (Pretty,2013(. The pH needed to begin loss of mineral in root dentin is in the ranges between 6 and 6.8, while th pH value that initiate mineral loss in enamel is (5.4). Therefore , these tissues are more susceptible to the process of demineralisation when compared with enamel (Damé-Teixeira, 2017).

2. Epidemiology of Root Caries

2.1. Prevalence of Root Caries

The prevalence of root caries is usually higher in older adults due to increased tooth retention and exposed root surfaces (Kassebaum et al., 2015).

Majority of the studies were from North America (pooled prevalence 36.8%) and Europe (pooled prevalence = 50.8%). A total

of 12 studies from Asia were reported (pooled prevalence = 34.6%;) (Thomson, 2013) . Prevalence of Root Caries in some countries has been shown in table (1).

Table 1:Prevalence of Root Caries Among Different Countries in The World

Author	Years	Country	Sample size	Percentage of prevalence
Alwaheb A.M	2000	Iraq	90	12.2%
Qasim	2010	Iraq	231	19.37%
Chi et al	2013	USA	368 (204 M, 164 F)	25%
Silva et al	2014	Australia	243 (80 M, 163 F)	77%
Christensen et al.	2015	Denmark	1,063 aged 65+	45%
Kumara	2016	Bangalore city (India)	70	46.4%
Talib & Majeed	2020	Iraq	2600(1352 males,1248 females)	22.3%

2.2. Distribution of Root

The root caries appeared to be higher in mandibular dentition than maxillary in all groups. This may be probably related to the characteristics of keratinized mucosa, which is wider and thicker in maxilla than in the mandible (Anarthe, 2013). The buccal or labial surfaces of maxillary and mandibular teeth revealed higher percentages of (RC) from other surfaces (lingual or palatal, mesial, distal) in all groups. This may be related to the improper tooth brushing habits which considered as an etiological factor of gingival recession (Veiga, 2014). Imazato in (2006) reported canines and first premolars as the most frequently involved teeth ,while Kularatne and

Ekanayake in (2007) indicated that the molars of both arches as the most frequently involved,

Root caries in the upper arch are more usually occur in the following sequence (central incisors, then canine, followed by premolar and molar tooth), while root caries In lower arch are more commonly spread in the following manner first at molar, then premolar, followed by canine and incisor tooth (Urquhart,2019).

2.3. Indices Used to Measure Root Caries Lesion

Index used for root caries was developed to overcome the limitations of DFS (Decayed, Filled Surface) index, because DFS index can not take into account the number of surface of tooth at caries risk (Nisha, 2013).

Root Caries index (RCI) developed by Katz 1980 is depend on the requirement that gingival recession must be present before the initiation of root caries . Therefore, teeth included in this index is only teeth with gingival recession. The root caries index was calculated for each subject as follow

$$RCI = \frac{(R-D) + (R-F)}{(R-D) + (R-F) + (R-N)} \times 100$$

R-D: recession with decay root surface

R-F: recession with filled root surface.

R-N: recession with a sound root surface(normal).

Ekstrand et al in 2008 developed a scoring system to determine the activity of root caries lesions in a clinical trial assessing different therapeutic regimes. The scores for each lesion are calculated, and a score of (3–5) is considered as an arrested lesion and (6–9) as active lesion. classification according to :

Texture of the lesion from(0_3), contour of surface (1_2), distance from lesion to the gingival margin and color of lesion .

International Caries Detection And Assessment System

(ICDAS) classifies and detects root caries based on the following criteria: color (light/dark brown/black); texture (smooth/rough); appearance (shiny/glossy,matte/non-glossy); perception on gentle probing (soft/ leathery/hard); cavitation (loss of anatomic contour) (Chen, 2015). In order to detect and classify root caries using ICDAS criteria a community periodontal index (CPI) probe should be used by the examiner. One score will be assigned per root surface as shown in table (2).

Table 2:Classification facial/mesial/distal/lingual root surfaces of each tooth(Chen, 2015).

Code	Description
O	Root surface does not have any unusual discoloration or surface defect,
E	Root surface cannot be seen by gentle air-drying or by direct vision
1	Clearly demarcated areas on root surface or at the cemento-enamel junction that is discolored but no cavitation present (loss of anatomic contour 0.5 mm depth).
2	Clearly demarcated area on root surface or at cemento-enamel junction that is discolored and has cavitation (≥ 0.5 mm).
3	Cavitated (>0.5 mm depth) carious root surface which is soft or leathery.
4	Cavitated (>0.5 mm depth) carious root surface which is hard/glossy indicating arrested/inactive caries.
6	Extensive caries including half of the tooth surface and spread to the pulp.
7	Root of the tooth is Filled root and without presence of caries

3. Etiology of Root Caries

Root caries susceptibility/risk is multifactorial and involves variations in the oral environment, periodontal status, invading

microorganisms in sub-gingival plaque, and host-derived proteolytic enzymes contained in saliva, gingival crevicular fluid, and dentin itself (Nyvad, 2016).

3.1. Decreased Salivary Flow

Appropriate salivary flow is an important contribution to oral health. Many substances in saliva help to maintain oral health . Salivary flow tends to remain constant from younger to older ages in healthy persons. The immune system weakens with age, and less antimicrobial immunoglobulins are found and produced in saliva (Taub, 2010).

Certain drugs, radiotherapy treatment for head and neck cancer, chronic rheumatic diseases like Sjögren's syndrome, and other systemic disorders like diabetes mellitus can all cause xerostomia (Carramolino-Cuéllar, 2018). There are over a thousand drugs that have been linked to xerostomia. The most common medications that cause xerostomia are tricyclic antidepressants, muscarinic receptor antagonists, antipsychotics, opioids and benzodiazepines, antihypertensives, and antihistamines (Aliko, 2015). β -adrenergic blockers, diuretics, ACE inhibitors, and drug combinations are among the most common antihypertensive drugs that have a strong link to salivary flow changes (Mancia, 2013).

3.2. Diet

The main important factor in preventing caries is diet because snacks and certain foods can dramatically increase the amount of bacteria that produce the caries producing plaque (Rodrigues, 2011). The most important factors that increase root caries development are the sweetened snacks and more frequently they are consumed. The elderly people are more susceptible to malnutrition (Volkert, 2013; Guerrero-García, 2016). The type of food used by elderly

people frequently involve high amount of carbohydrates and less amounts of micro and macronutrients (iodine,calcium,vitamin B12, phosphorus,zinc and vitamin B2) (Boirie, 2014; Rakıcıoğlu , 2015).

3.3. Bacteria

Bacterial species typically associated with root caries can be detected, such as *Streptococcus mutans*, *lactobacilli*, and *Actinomyces*. Bacterial profiles associated with root caries in elderly subjects exhibit reduced diversity (Preza, 2015).

3.4. Oral Hygiene

The important factor in the development of oral disease is oral hygiene. There is increased morbidity with ageing usually results in dependence and frailty on the care of others, nearly all of which increase susceptibility to acquiring oral diseases and the risk of worsening to oral health (Afshar, 2015). The important factor in the maintenance and improvement of oral health in older adult is professional cleaning performed by a dental hygienist every two weeks on older adult (Barbe et al., 2019). Moreover, domiciliary dental care allows persons with cognitive impairment and/or functional restrictions to get dental care at home (Ishimaru, 2019).

3.5. Systemic Diseases

Diabetes and periodontal disease are known to have a bi-directional relationship (Preshaw, 2011). Diabetes is associated with multiple oral conditions such as periodontal disease, delayed wound healing, taste alteration and oral infections (Napeñas, 2020).Periodontal disease is an inflammatory condition in response to the presence of dental plaque. diabetes increased the incidence and progression of periodontitis by 86% (Nascimento, 2018). Rheumatoid arthritis is a chronic inflammatory auto-immune destructive disease

affecting multiple joints (Bansal, 2016). This disease is the common cause for disability due to joint pain, inflammation-induced joint swelling and joint deformity caused by bone and cartilage destruction. These result in chronic pain and limited dexterity which make patients difficult to perform proper oral hygiene practice. Rheumatoid arthritis damages salivary glands and causes xerostomia. It also associated with oral complications such as periodontitis, temporomandibular joint dysfunction and its treatment can lead to methotrexate- induced oral ulceration(Serha, 2020).

4. Specificities of Caries on Root Surface

Caries lesions located on the root surface have diagnostic and treatment specificities. Root caries is qualitative and substantially different from coronal caries. To effectively manage root carious lesions, the understanding of its basic characteristics is crucial (Karger, 2017).

4.1. Dental Hard Tissues and Their Composition

The organic and inorganic composition of each tissue varies and reflects characteristics of both of them. Enamel has a higher inorganic composition (90 % prismatic crystals) than any other hard tissue in the body, making it more durable and stronger. Cementum on the other hand, is composed of 45– 50% inorganic and 50% organic by dry mass, primarily collagen type I (AbouNeel, 2016). Dentin has a complicated structural component similar to cementum, and contains higher amount of organic material than enamel. Dentin is composed of roughly 70% inorganic materials, 18% organic elements, and 12% water by wet weight (Goldberg, 2011). The organic composition of these tissue make root hard tissues more resilient in compared to enamel. In spite of hexagonal crystals of hydroxy-apatite, $\text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2$ make up the inorganic component of all hard tooth tissues,

the crystal size is smaller and the mineral composition of the root surface is lower than that of the enamel. The magnesium and carbonate contents of dentin/cementum have been found to be higher than those of enamel (6.2 and 1.2 %, respectively). Cementum has a narrow width, predicted to be roughly 50nm in person 20 years old. Scaling and root planing, as well as excessive toothbrushing, remove this thin layer of cementum, exposing the underlying dentine. Therefore , root caries more commonly found in root dentine than in cementum (Nyvad, 2016).

4.2. Gingival Recession and Exposure of Root Hard Tissues to Oral Environment

The exposing of the tooth root induced by the migration of the gingiva to a position apical to the cemento-enamel junction is known as gingival recession(figure 1). The occurrence of gingival recession is caused by some factors : such as anatomical factors ,inflammatory disease (factors relative to iatrogenesis (e.g. prosthetics, orthodontic treatment); factors relative to trauma (traumatic brushing or other mechanical traumas) (Bueno, 2015).



Figure 1:patient with gingival recession (keerthana, 2017)

5. Biochemistry of Root Caries

The root caries process is divided into two parts. Mineral dissolution characterizes the first stage, while deterioration of the root

surface's organic matrix characterizes the second (Takahashi, 2016).

5.1. Mineral Dissolution

Because the mineral in the root is more soluble than that in the enamel,

demineralizing the root surface is considerably easier than demineralizing the enamel surface. Some carbohydrates that are acceptable for enamel may be cariogenic for root surfaces, such as sweets with lactose as a bulking agent (Giongo, 2014). Similarly, it has been claimed that dental biofilm bacteria digesting starch products is adequate to generate root caries but insufficient to cause enamel caries. Starch alone did not cause demineralization in enamel, however complex carbohydrates like starch contribute to dentin/cementum caries. In addition, combining starch with sucrose increased the sucrose effect in demineralization in both enamel and dentin. This could be related to the starch digestion by surface-adsorbed amylase (Botelho, 2016).

5.2. Organic Matrix Degradation

The destruction of the collagen matrix in the root hard tissues is linked to the progression of caries lesions. Collagen type I is a heterotrimer structure, which is the most frequent in dentin. The collagen structure contributes to the molecular stabilization and mechanical properties of the dentin. Only a specific group of proteases, the collagenases, would be able to degrade native collagen. The exposed collagen is broken down, and the collagen content could be denatured during the second stage of caries process. It was suggested that collagen matrix degradation could only be possible after demineralization and the reason is that the substrate is not approachable for collagenases in the mineralized tissue (Takahashi, 2016)

6. Arested Lesion

Souza in (2013) proposed that when patients have lesser RC lesions and the lesions themselves have much less plaque, a smaller surface area, and are much further ahead from the gingival margin, the lesions have a better chance of inactivation. The existence of a distinctive mineralized, hard surface layer is the most distinct feature of inactive lesions. A distinct layer of sclerotic dentin separates the lesion from the underlying sound dentin. A further characteristic of

inactivated lesions is the existence of intratubular mineralization with an irregular precipitation pattern in the dentin tubules, with ghost cells of microorganisms found between these crystals.

7. Microbiology of Root Surface Caries

In comparison to other dental disease , knowledge of the microbiological pathogenesis of root caries is still restricted (Chet et al, 2015). The microbiota of sound and carious root surface biofilms was compared in subsequent human research. Mutans streptococci were reported to make up a third of the total microbiota of cavitated dentin lesions in early culture-dependent studies, implying that these species play a key role in caries progression. Various

microorganism such as *lactobacilli*, *Prevotella*, and *Bifidobacterium species*, were reported to be more abundant in later stages of caries. *Bifidobacterium*, *Rothia*, *Veillonella*, *enterococci*, *anaerobic Gram-negative rods*, and *Candida albicans* have all been found (Shen, 2005).

Some of researchers suggested that bacteria that cause root caries are less depend on refined carbohydrates than those that cause coronal caries. This could be owing to changes in the structure and composition of different tissues, and also the microenvironmental conditions. For example, dentinal lesions offer a greater range of

nutrients, resulting in increased in number of the associated microbial communities (Simón-Soro, 2014 ;Rôças, 2016).

8. Diagnosis and Assessment of Root Caries Lesion Activity

The activity of RC lesions has traditionally been assessed based on their visual appearance (color) and tactile sensation. Nyvad in (2015) suggest a diagnostic criteria depending mostly on tactile sensation and gingival margin position from the lesion. Active lesions are soft or leathery, and are located at plaque retention along the gingival margin or along the cemento-enamel junction; inactive (arrested) lesions are hard on probing, have a shiny aspect, and are located some distance from the gingival margin (Soviero, 2015) .

9. Management of Root Caries

Primary, secondary, and tertiary prevention are used to treat root caries, just as they are for other diseases. Practices and procedures performed prior to the beginning of root caries are referred to as primary prevention. Secondary root caries prevention focuses on persons who are early in the disease stage in order to stop or repair it. Root caries lesions that cause problems such as cavitation, loss of function, and pain are the focus of tertiary prevention (restorative treatment) (Cochrane, 2017).

9.1. Prevention of New Root Caries and Arresting of Existed Lesion

Early root caries lesions can be treated without surgical intervention using preventive and remineralising approaches such as plaque control, dietary advice, and application of fluoride (Burrow and Maltz, 2017). Non-invasive interventions in the form of 5000 parts per million (ppm) fluoride toothpaste and professionally applied sodium fluoride varnish,

chlorhexidine varnish, or silver diamine fluoride have been recommended to arrest non-cavitated or cavitated root caries lesions and seem to be more effective in arresting root caries lesions in comparison to conventional fluoride toothpaste or placebo interventions (Slayton, 2018; MeyerLueckel, 2019).

9.2. Conventional Preventive Therapies (Fluoride) on Root Caries Lesions

Fluoride has been widely applied for the prevention of dental caries, including RCLs (Richards, 2009). Fluoride is known to reduce demineralization and improve remineralization. Further, it has some antimicrobial effect by reducing bacterial metabolism and interfering in proton extrusion (Buzalaf, 2011). However, most evidence on the effectiveness of fluoride in preventing dental caries is limited to populations of children (6–15 years old). With regard to RCLs, some evidence about the benefits of fluoride comes from clinical trials published in the last 10 years. The most tested products containing fluoride are toothpastes, especially those containing 5,000 ppm F (applied twice a day), fluoride varnishes (5% NaF, applied every 3 months), and silver diamine fluoride solution (38%, applied once a year). Adjuvants of oral hygiene have also been evaluated in regard to root caries. Three monthly applications of chlorhexidine-thymol varnish (Cervitec) over one-year limits the progress of existing root caries lesions and reduces the incidence of root caries (Baca and Clavero, 2009). When fluoride varnish, 1% chlorhexidine, 40% chlorhexidine, and professional tooth cleanings were compared in regard to root caries, all methods showed significant reduction in the amount of microbiota (bacteria). These data suggested that tooth cleaning alone might be as effective in reducing plaque formation (and subsequently root caries) as fluoride or chlorhexidine (Bizhang,

2007).

9.3. Self Applied Fluorid Products

In clinical studies over 6–8 months with older adults, including crippled nursing home residents, highly concentrated fluoride toothpastes (5,000 ppm F) were demonstrated to dramatically stop RCLs (by hardness analysis) in comparison to regular toothpastes comprising 1,350–1,450 ppm F (Srinivasan, 2014). The use of 5,000 ppm F toothpaste 2 times a day can raise fluoride concentration in biofilm and saliva, and also the development of CaF₂ on teeth, while lowering biofilm formation and *S. mutans* and *Lactobacillus* levels (Ekstrand, 2016). As shown in a meta-analysis, when uses 5,000 ppm F is compared to 1,100–1,450 ppm F, the relative risk for RCLs is much lower, with a high level of evidence (Meyer-Lueckel, 2015). Mouth rinses usually contains 225–900 ppm F – as NaF were also found to reduce decayed, missing, and filled root surfaces (DMFRS) when compared to placebo (SMD = – 0.18) (Wierichs, 2015).

9.3.1. Professional Applied Fluoride Products

The most commonly evaluated professional-applied materials for RCL reduction are silver diamond fluoride solution/varnish and NaF varnish. During 24–30 months of follow-up, a yearly treatment of 38 % silver diamine fluoride (figure 2) has been found to prevent and reverse RCLs in older adults when compared to education alone (Wong, 2016). Li et al in (2016) suggested that in a 30-month research study, 90 % of RCLs arrested after being treated with silver diamine fluoride, compared to 45 % in the control group. The prevention of RCLs in institutionalized elderly people was also compared using 1% chlorhexidine varnish, 5% NaF varnish (both every three months), and 38 % silver diamine fluoride solution (once a year). Chlorhexidine, NaF, and silver diamine fluoride have been

demonstrated to inhibit the production of new RCLs by 56–57, 64, and 71–72 %, respectively, with no substantial changes detected after three years (Dyson,2010) .Table (3) demonstrated some studies using different fluoridated agent .In a high-risk group, Schwendicke and Göstemeyer found that silver diamine fluoride (2/year) would be a more cost- effective technique than NaF (daily mouth rinse application) or chlorhexidine (2/ year) (Göstemeyer, 2017). Silver diamond fluoride is also used in prepared cavity lesions to reduce the formation of secondary root caries surrounding CIV fillings, with no evidence of affecting adherence in vitro (Mei, 2017).



Figure 2:Use of Silver Diamine Fluoride to arrest Root Caries (Jeremy, 2016).

Table 3:The influence of various fluoride compounds in preventing or stopping root caries in older adult

Author	Year	Sample size	Fluoride product	Main result
Srinivasan et al	2014	130	5,000 vs. 1,350 ppm F Tooth pastes (twice a day)	2.4 vs. 2.8(0.05)
Li et al.	2016	67	SDF (each year) vs control	90 vs 45%
Xin et al.	2016	78	5% NaF vs. placebo varnish	1.4 vs.2.7(ns)
Abdurhman L.	2021	93	SDF VS Placebo	65.7 vs 20%

9.4. Plaque Control

Root caries is more prone to occur on root surfaces with visible plaque, denture contact, or gingival recession. It has been demonstrated that the development of new carious lesion can be prevented during the maintenance phase of periodontal treatment by regular individual and professional tooth cleaning (Tan, 2014).

9.5. Dietary Control

There is a clear link between increased consumption of low molecular weight carbohydrates and caries incidence in developed countries (Balhaddad, 2019). Organic acids are produced as a result of the anaerobic metabolism of fermentable dietary carbohydrates, which is the main factor of the demineralization process that causes tooth caries (Melo, 2019). As a result, patient education regarding dietary habits is an important part of caries prevention programs. People should be advised to avoid eating high-sugar foods and snacks on a regular basis. However, it appears to be difficult to limit sugar consumption in the general population, because the body's subsequent pleasure response to the sweet taste is remarkably similar to that linked with addictive behaviors (Avena,2008). One option for addressing this problem is to replace fermentable carbs with non-cariogenic sugar alternatives such as xylitol or sorbitol to reduce sugar intake (Burt, 2006).

9.6. Remineralization of Root Caries

Remineralization could occur during periods of change in the environmental condition prevailing in the dental biofilm covering a root caries lesion, for example a return to neutral pH, and by replenishing the calcium and phosphate content removed during demineralisation. Thus, the control and reduction of dietary

carbohydrates, the modification and reduction of cariogenic dental biofilm or the application of chemical agents, such as fluoride, chlorhexidine or Casein Phosphopeptides-Amorphous Calcium Phosphate (ACP-CPP), could inhibit demineralisation and promote remineralisation (Rodrigues, 2011).

9.7. Role of Laser in the Prevention of Root Caries

The majority of experimental studies indicate that topical fluoride and laser therapy have an additive or synergistic influence in preventing root dentin demineralization. In vitro, the use of Erbium YAG (Er YAG) laser (Geraldo-Martins, 2014) or CO₂ lasers in conjunction with a 2 % NaF gel increased acid resistance of human root dentin, close to what had been seen with CO₂ lasers in conjunction with 1,23 % APF (acidulated phosphate fluoride) gel or 5 % NaF fluoride varnish , Er:YAG laser combined with silver diamine fluoride. These synergistic impact appear to be linked to increased fluoride uptake by dentin, and also the laser-induced reduction in calcium and phosphate loss (Chu, 2014; Esteves-Oliveira, 2017) .In vitro, irradiation with a CO₂ laser reduced dentin mineral loss around composite resin restorations, but not for patient treated with a fluoride releasing substance (glass ionomer cement) (Melo, 2014; Daniel, 2015).

9.8. A traumatic Restorative Technique

The a traumatic restorative technique (ART) is an alternative technique in which the softened tissue of the lesion is removed with a manual instrument and is sealed with an adhesive material such as glass ionomer cement, typically high viscosity glass ionomer cement) (HVGIC) (Frencken, 2012) . When compared to conventional treatment (CT) using rotary equipment, a main advantage of this technology is its application in nontraditional clinical settings,

because the requirement for complicated apparatus and materials is greatly reduced. Cavity preparation with hand devices also minimizes pain and discomfort in patients, allowing local anaesthetic to be avoided in many cases. In different contexts such as care facilities, at home, or in dental practices, restoration of root caries lesions using the ART approach may be more appropriate than CT for older patients (Cruz Gonzalez et al., 2016).

The ART method has also been adopted with the use of a chemomechanical caries method in a study for the management of root caries lesions in the elderly. This study compared the standard ART method of hand excavation of the soft caries with ART using a chemochemical method of caries excavation with Carisolv. This 2-year study showed an overall 63% survival rate of restorations. The same degree of restoration survival was achieved when Carisolv was used. The ART method is promising as a means of management of cavitated root caries lesions and may be a useful alternative for institutionalized patients unable to attend a dental office (Gil-Montoya, 2014).

9.9. Restorative Treatment

Restorative treatment is indicated when the structural integrity of demineralized dentine has been destroyed. For the filling of cavitated root surface caries lesions, the traditional method of "drilling and filling" is most usually performed,(Da Mata et al, 2015). To treat root caries lesions, (GIC), amalgam , (RMGIC), (compomers), or composite resins are widely employed. If a color change has taken place, it may be important to take into account some type of aesthetic enhancement once the root caries lesion has been arrested, and restorative treatment may be provided (Mount et al., 2016).The main objective of root caries restorative treatment is to

stop the damaging cavitation process and restore the tooth's function and aesthetic by restoring the damaged components of its structure. For the elimination of decayed dental tissues and cavity preparation, the classical restorative technique needs the use of power driven dental rotary device. ART is a minimally invasive technique that involves removing soft demineralized tooth tissue with only hand instruments and then restoring the tooth with a fluoride releasing adhesive dental restorative material (Frencken et al .,2014)

9.10. Cavitated lesion management

Cavitated lesions can be treated using a variety of techniques. The main management approach should be concentrated on minimal intervention procedures targeted at maximum preservation of tooth tissue, i.e., surgical care of the lesion should be used only as a last option. To reduce the size of the cavity and restore it, a combination of initial remineralization and surgical intervention is often used (Monogr, 2017).

9.11. Biofilm Disruption

Cavitated lesions should be evaluated to see if the biofilm on the entire lesion surface can be eliminated with a toothbrush, even depth of approximately 2 mm. If a patient can regularly remove biofilm, this non invasive type of lesion care could be the best option. Routine biofilm elimination with a toothpaste that contain high fluoride concentration, such as 5,000 ppm, as well as the usage of other remineralizing agents including such Ca and PO₄ containing crèmes should be implemented. Brushing also abrades the weakened lesion surface, revealing the underlying strong with greater mineral content in dental tissue (Ekstrand, 2016).

9.12. Lesion

Exposure

Method

Instead of removing the carious tissue, a minimum surgical approach that exposing the dentin lesion by removing only the overlying unsupported enamel can be performed in select cases where lesions have shallow cavitation but spread below the enamel. This procedure is carried out by using a fine-grit tapered or flame-shaped diamond bur under air water spray in either a low and moderate (1:5 increase) speed hand piece, the procedure is performed without the requirement for local anesthesia. After the dentin lesion has been exposed, the patient receiving lesion-specific oral hygiene advice, involving the use of high concentration of fluoride toothpastes (Karger, 2017)

9.13. Caries Excavation and Restoration

The goal should be to prevent pulp exposure when removing the dentin. In a clinical study compared GIC with Biodentine on root caries lesions, the GIC was found to be far more efficient in terms of restoration longevity (Hayes, 2016) .

9.14. Material Selection

The development of adhesive dental materials has simplified the utilization and selection of materials for root caries restoration. Silver amalgam was the sole material accessible before these materials were available. The corrosion products of silver amalgam are likely to assist decrease the recurrence of caries near restoration margins and also influence the growth of the biofilm (Beyth, 2007). The fact that it is non-adhesive is one of its major drawbacks.

Although the restoration is usually not load bearing, the cavities should have a well defined retention form and be deep enough to provide the amalgam strength. Because root lesions have shallow, ill defined margins, cavity preparation for amalgam involves the elimination of sound tooth structure and also marginal extension

to sound tooth structure, which is challenging for root lesions (Montoya et al.,2021).

The adhesive restorative materials, on the other hand, can be applied in very thin layers, avoiding the loss of tissue which is easily to be remineralized . GIC, either the classic or resin-modified version, is presently the most popular alternative. In the case of materials made of resin, a resin-based system is not recommended in situations where moisture control is difficult to regulate. Only GIC remains as a viable option. Therefore, a technique of preparing the dentin to be filled with GIC, dentin should be conditioned with polyacrylic acid (PAA). PAA begins to react with the calcium in the tooth mineral via an ionic interaction, resulting in greater adhesion (Es-Souni, 2002).

PAA conditioning also helps in cleaning the cavity and eliminate any saliva or blood debris that could interfere with adhesion to dentin . For individuals with normal saliva flow or where the gingival floor of an approximal cavity extends more than 4.5 mm below the occlusal surface of the tooth, contemporary fast-setting conventional GICs with high strength and higher fluoride release are the preferred material (Zhao ,2017) .

To accomplish good bonding, good moisture control is necessary . According to current data, a three-step etch and rinse technique will give the maximum benefits (Peumans, 2014). The selection of composite restorative material, flowable vs. microfill vs. nano or microhybrid, is still challenged. The ability to polish a material to a very high polish with clean margins is the most crucial factor to consider when choosing a composite. This will make it easier for the patient to remove biofilm, lowering the risk of further demineralization at the restoration margins (Cury ,2016) .

A third method is to employ a resin-modified glass ionomer

adhesive to adhere to the root dentin, such as Fuji Bond LC (GC Corp) or Riva Bond LC , and then filled the cavity with a resin composite. This provides the practitioner with the benefits of strong root dentin bonding via the GIC. maximal aesthetics, and a smooth resin composite margin. When placed in cavitated lesion for 5 and 6 years, two studies have showed good restoration longevity. As a result, this technique may be beneficial for root caries patients who suffer from salivary insufficiency (Dijken, 2005).

Conclusion

The number of elderly people increasing in the last decade. The most common dental disease affecting the older people are root caries and periodonal disease. Root caries is soft progressive lesion which affect root surface that exposed to the oral environmental. The root caries is either active that appear clinically as yellowish or light brown or inactive (arrested) that appear clinically as brownish or dark brown. There are many factors that predispose older people to root caries, the most important one is gingival recession. The prevention of root caries is challenging for older people since it require co-operation of patient to achieve better result. The use of high concentrated fluoride (5000) is important for prevention. The treatment of root caries is also a challenge and if the lesion is shallow, the treatment involve removal of plaque, smoothening of surface and application of fluoride, while if the lesion is deep, it involve cavity preparation and placement of restorative material.

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